DOT/FAA/AR-96/50

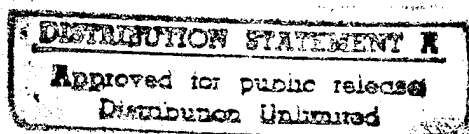# An Evaluation of the Explosives Detection System CTX5000 User Interface for Alarm Resolution

J. L. Fobes, Ph.D.
S. M. Cormier, Ph.D.
J. M. Barrientos

Aviation Security Human
Factors Program, AAR-510
FAA Technical Center
Atlantic City International Airport, NJ 08405

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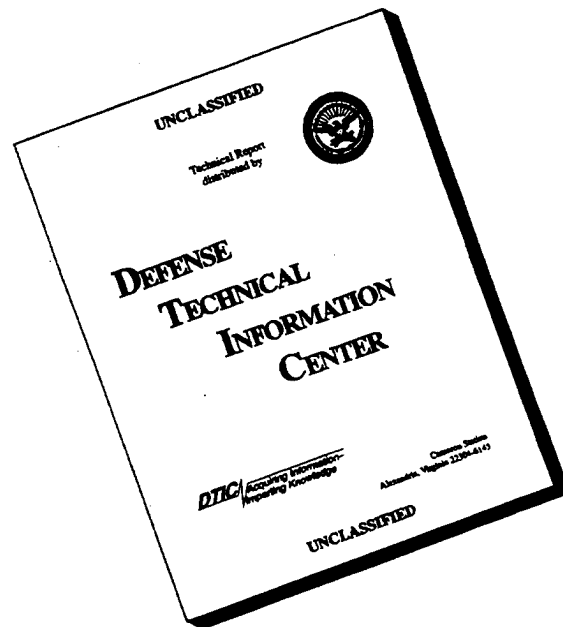
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16. Abstract

This report provides an evaluation of the CTX5000 human-computer interface including the X-ray interface, the Computed Tomography (CT)-scan interface, the manual input interface channels, and the workstation design. It does not make recommendations for the reconfiguration of screens nor does it make recommendations as to possible changes in the software infrastructure.

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1.0 INTRODUCTION

The CTX 5000 is a Computed Tomography (CT) device being used to detect explosives in air carrier checked baggage. It automatically loads checked baggage into the imaging chamber, processes an X-ray image of the bag, produces several CT slices, and reports to the screener if there are any explosive materials. Based on this report, screeners evaluate suspected threat objects to resolve equipment alarms.

This report provides an evaluation of the CTX5000 human-computer interface (HCI) including the X-ray interface, the CT-scan interface, the manual input interface channels, and the workstation design. It does not make recommendations for the reconfiguration of screens nor does it make recommendations as to possible changes in the software infrastructure .

1.1 Criteria for Evaluation

This evaluation was conducted within the context of the following criteria and weighted as listed below:

- time to learn
- speed of performance
- user error rate
- retention over time
- subjective satisfaction

This report provides recommendations for enhancing the HCI that will increase screener speed in resolving alarms while also maintaining or decreasing the rate of screener false alarms. I is important to note that these recommendations are made according to principles of good user interface design. No opportunity existed for subject matter expert data collection, although this is strongly recommended. Data collection should follow a naturalistic observation evaluation methodology in which system users are observed, responses to varying situations encountered are recorded, and comments about the system recorded. Techniques such as protocol analyses, structured walkthroughs, talkthroughs, and focus groups should also be used. The outcome of these procedures will result in a system which will be minimally intrusive to the baggage screening task

1.2 Software Version

The CTX5000 software version in effect at the time of this evaluation was 6.10H, Inspection 6.1.15.

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2.0 Premature Clearance

Issue #1

It is imperative that a bag is fully scanned and all images processed prior to the bag exiting the CTX 5000.

Solution

Due to the potential consequences of not scanning a bag, it is recommended that a software change be implemented which prevents a bag from being cleared by the operator prior to full scanning and processing of the images by the CTX 5000.

3.0 Screener Threat Resolution Keys and Displays

The CTX 5000 alarms on explosive materials as well as on some non-explosive material (false alarms). After the machine alarms, the task of alarm resolution is placed on the screener who must decide whether or not explosives are present. An HCI evaluation revealed several general system categories that could be enhanced to more effectively present information to the screener.

- Default X-Ray/CT Scan Image
- Console Design
- CT-Display Soft Keys

3.1 Default X-Ray/CT Scan Image

Issue #2

The X-ray image represents a top-down view of baggage on the conveyor belt. The CT-Scan image represents a left-right view of a cross section image of that baggage. The default displays are an X-ray display of the bag image at a different angle then that displayed on the CT screen. This increases screeners' search time, both within and between displays, to locate and identify nonthreat objects and threat objects. This issue is further aggravated by the lack of a standardized manner for orienting baggage on the conveyor belt. Screeners have to determine the orientation of the baggage before they can identify the orientation of the threat objects.

Solution

Develop a second X-ray image, which has the same left-right orientation as the CT slices, so that the screener can more easily compare an X-ray of that image to the CT-Scan image.

Issue #3

The X-ray image displays CT slice lines at both the top and bottom of the image. The display does not provide a good indication of the exact location of the slice but instead requires the eye to extrapolate either up or down from the leader lines through the entire image.

Solution

Extend slice lines so that they overlay the X-ray image. This should be the default display with an the option for the screener to toggle off the extended lines to see the unoccluded image.

Issue #4

The slices on the X-ray image are not numbered making it difficult to correlate the slice on the X-ray image with the slices represented on the CT-Scan.

Solution

Number the slices from left to right with numbers appearing just above and below the slice end points .

Issue #5

The status region at the bottom of the X-ray screen is not distinct enough to convey the pertinent information.

Solution

Place this information in a legend to the right or left of the X-ray image.

Issue #6

The method of indicating where more CT slices should be taken is cumbersome and slows alarm resolution.

Solution

Enable the screener to define both the left and right boundaries of the area of interest by pressing down the trackball button and dragging the trackball so that a box forms around the area for additional slices.

Issue #7

A *shield* alarm is represented as a yellow highlighted area on the CT image and yellow also indicates a threat not currently being looked at. The use of yellow to indicate two different meanings within a single display is contrary to good user interface design.

Solution

Use some other color not currently being used.

Issue #8

The Mass/Density/Exp region is not central enough to cause the screener to attend to the information.

Solution

Make the Mass/Density/Exp. display region more distinct by boxing in this area (black borders with white background).

Issue #9

The relationship between the 6 small CT images and the large CT image is not clear.

Solution

The large image should also be displayed as a small image in the correct linear order. That small image should be highlighted to indicate the present image being viewed as a large image.

Issue #10

When more than one threat is represented, boxes are placed around each of them. However, these boxes are not numbered and the operator cannot know or control the order used to move from box to box as the NEXT THREAT key is pressed. This will inevitably cause the screener to continually attempt to re-correlate the X-ray image and the CT-scan image to ensure looking at the desired object.

Solution

Number the boxes in both images and make sure that the box numbers are synchronized between the two images.

3.2 Console Design

Issue #11

The lighted key coding strategy may cause initial confusion for operators. As stated in the CTX 5000 manual, when a hard key is lit, the function is available. The exception to this rule, however, is that for two modes the hard key is lit when active (i.e., in progress) and is not lit when available (but inactive).

Solution

It is recommended that when a function is available, the hard key will be have a green color light. When the key is not available it will have no light. When it has been activated and is in progress, the key will flash white.

Issue #12

The images on the display console are not of the bag in the scanner, but instead for the bag on the holding conveyor. With the current default mode (NEVER HOLD mode), the screener would have to reload the baggage in question to continue threat resolution by requesting additional slices.

Solution

Allow the site supervisor to set the default mode for this function and others.

3.3 CT-Display Soft Keys

Issue #13

Using one trackball to operate a singular cursor across two screens may disorient the typical user of two display systems.

Solution

Provide an auditory cue (e.g. a click) and visual cue (e.g. a momentarily brighter cursor) when the cursor moves off one screen and onto the other. This will make it easier for the operator to locate and track the cursor.

Issue #14

Unavailable soft key text should not be dimmed to blue which is not commonly associated with an inactive or unavailable function.

Solution

Unavailable soft keys should have their text dimmed to gray.

Issue #15

Color coding to connote "function in-progress" operation features a small dot alternating between green and gray. This is highly ineffective because the location, colors, and size of the cue is not conspicuous.

Solution

The entire function key should flash when a function is in progress. A recommended color scheme is having the function flash between a black text/white background and the inverse.

Issue #16

Color coding to connote function on/off is not the most effective way to convey this information.

Solution

To indicate a function that is on, use an inverse of the default test/background colors. In this case, it would be white text on a black background.

Issue #17

The use of gray coding is commonly associated with an unavailable function but is instead being used as the button background of an inactivated soft key.

Solution

Use another color that provides an adequate contrast ratio with the button text (e.g., white or cyan).

Issue #18

Names on keys should not be abbreviated.

Solution

Spell out function name completely.

Issue # 19

Potential detonators should not be displayed in grayscale since both images are displayed in grayscale and this would cause the detonators to "blend in".

Solution

Eliminate this function option.

Issue #20

The Hi X-RAY POWER soft key should not also be used for adjusting contrast since that is a separate function. The software is designed so that the HI X-RAY POWER soft key must be clicked on to return to the preset contrast since that is a separate function.

Solution

Install a CONTRAST RESET soft key.

Issue #21

The X-RAY IMAGE CONTRAST CONTROL is not so labeled.

Solution

Label the control.

Issue #22

Magnified slices are not numbered.

Solution

Number the magnified slices so that users know the location of magnified slice relative to the entire image.

Issue #23

While zooming an image to fill the screen, the screener does not have continued awareness of the relative location of that zoom to the overall image.

Solution

Provide a small window representation of the overall image as an inset to the zoomed image.

Issue #24

It is difficult to hold down a trackball button and roll the trackball at the same time to create the movie.

Solution

When the cursor is placed on the small blue CT slice lines, the screener should be able to press the trackball button once to lock in the movie mode (and the cursor into that region of the screen), then slew the trackball over that region. An alternative is to have the CTX 5000 create the movie to run in an endless loop simply by creating a function key for it.